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Jørgensen, Kirsten

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Prevention of ”simple accidents” with major consequences

Associated professor, PhD

DTU Management Engineering

The program

1. **Some figures**
2. **The question: are all accidents of the same kind?**
3. **The cause-consequence process**
4. **What we know and what we don´t know?**
5. **Safety barriers**
6. **INFO cards**
7. **How to create safety?**

Eurostat data notified accidents x 1000 for 27 EU countries (Unknown not showed)

Severity:	Fatal	Perm. Invalidity	1-6 months absent	4-30 days absent	Total
Year 2009	4	99	541	1511	2,440
Year 2010	5	83	452	1251	2,059
Total	**9**	**182**	**994**	**2762**	**4,499**

Accident causes

	% of all Notified accidents	% of all fatal accidents
Electrical probl., explosion, fire, etc.	**11 %**	**23%**
Technical equipment	**22 %**	**38%**
Falls	**23 %**	**19%**
Body movement and violence	**42 %**	**13%**
Other deviation not listed above	**2 %**	**6%**

The Accident phenomenon

It is normal to focus on the so-called high risk like fire, explosion etc.

While the simple risks has very little focus or awareness

98% of all accidents is ”simple” looking at the deviation and the injuring agent

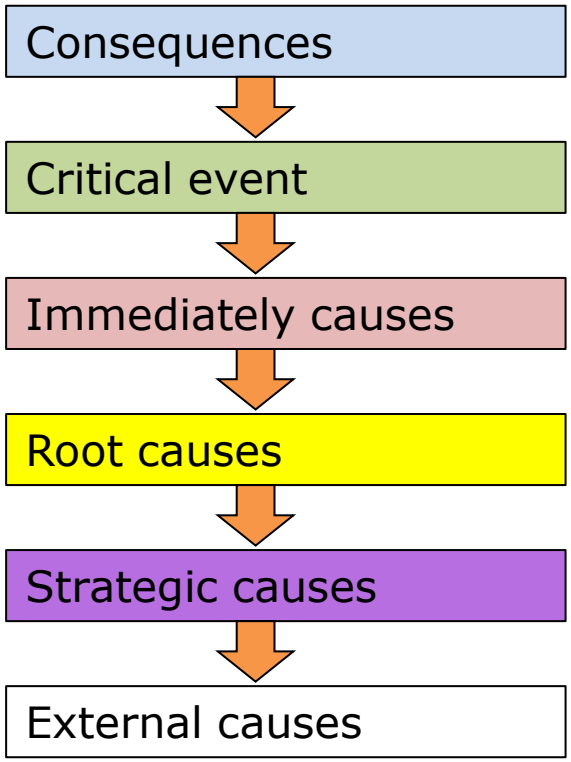
Most accidents is caused by risks we do not take serious or are special aware of and because of that we do nothing about it.

Is accident one of a kind

- Definition
- Frequency and seriousness
- Hazard information
- Accident investigation
- Blame and guilt
- Risk awareness and risk aversion

The definition can be used for all kid of accidents, but the condition for prevention for different type of accidents have major differences

The accident causation process



1. The injury and the victim,

2. Deviation and harmful agent

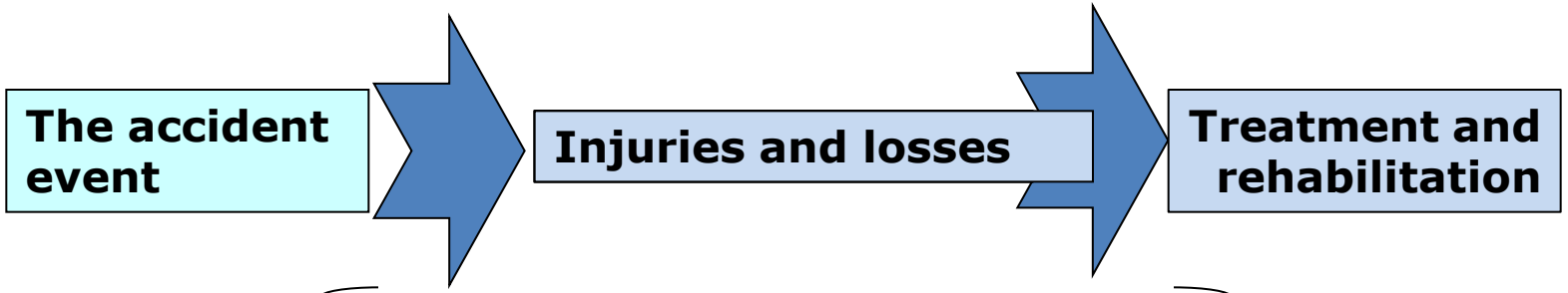
3. The work situation and the victims' behavior.

4. Management conditions and processes delivering controls.

5. Management's strategic prioritization and commitment.

6. Legislation, competition, market relations, stakeholder requirements etc.

The consequences



The Injuries

- Fatalities
- Amputation
- Fracture
- Back pain
- Sprain and strain
- Wounds
- Poisoning
- Infections
- Electrical chock
- Burns and scalds

Losses

- Employee sick leave
- Constructions damages
- Technical equipment damages
- Production losses
- Quality failures
- Customer delays

Costs = average 5.000 Euro pr. accident

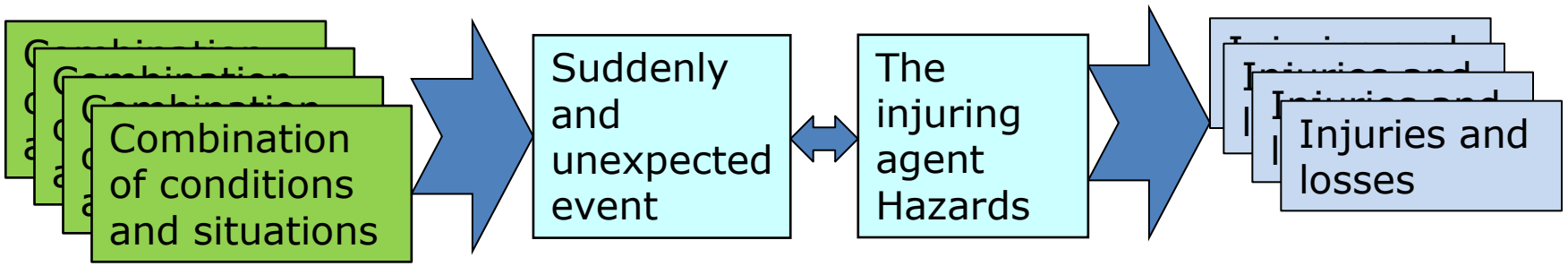
The critical event

Active Protection

- Ability to observe
- Ability to react
- Ability to avoid

- Use of personal protection equipment
- Use of technical protection devises
- Separation in time and place

Passive Protection



Events

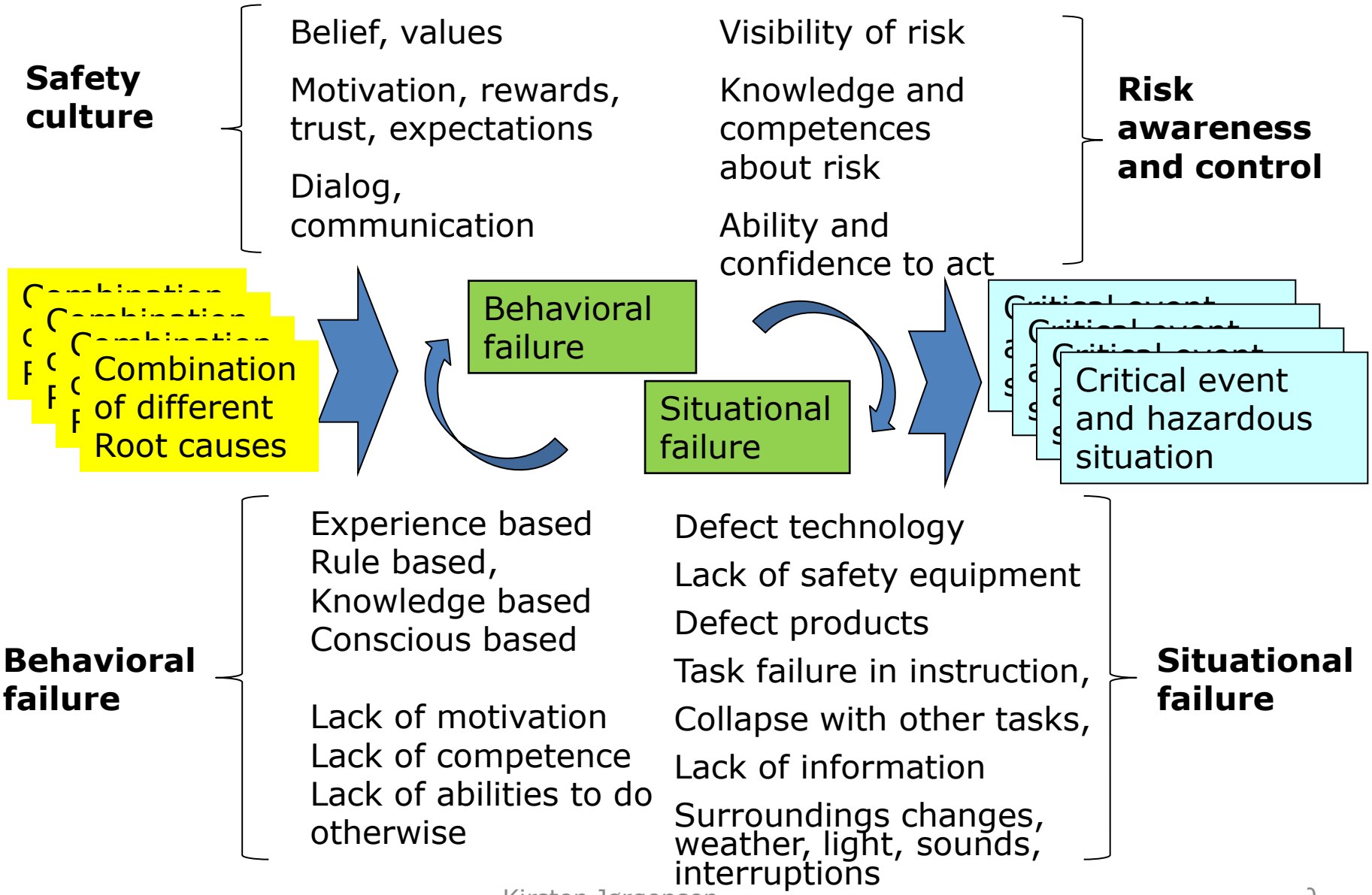
- Falls , collapse
- Falling agents
- Collisions, flying objects
- Fire explosions
- Inappropriate movements
- Breakage, bursting
- Vaporization, overflowing,
- Aggression

- Sharp edges
- Moving parts
- High pressure
- Kinetic energy
- Potential energy
- Heath, frost
- Electricity

- Light
- Noise
- Chemicals
- Heavy lifting
- Radiations
- Violence
- Lack of oxygen

Hazards

Immediate causes



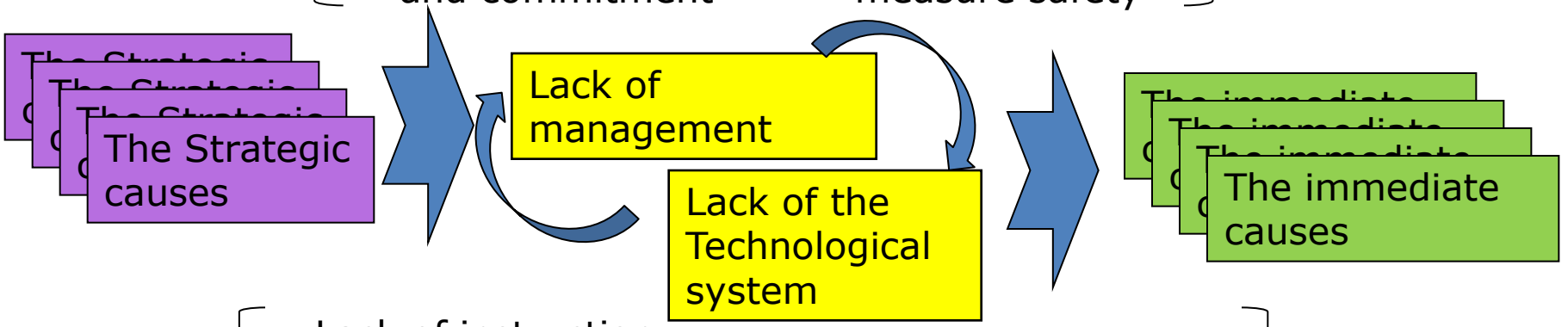
The root causes

Behavioral safety barrier

- Procedures, rules, plans, goals
- People with right competences
- Coordination, dialog and commitment

- Purchase safe equipment and workspace
- Secure safe use
- Maintain and measure safety

Technical safety barrier



Lack of manage-ment

- Lack of instruction and training
- Lack of procedures, standards
- Lack of communi-cation and dialog
- Lack of planning

- Lack of technical safety
- Lack of maintenance
- Lack of cleaning
- Poor building sites
- Poor environment
- Lack of road safety
- Poor workspace

Lack of the technolo-gical system

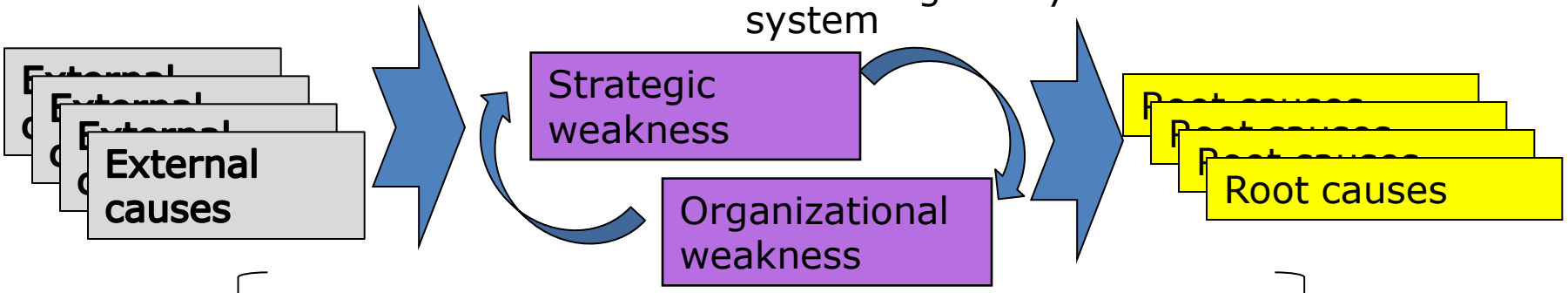
Strategic causes

Management commitment

- Goals, values, beliefs
- Prioritization of safety
- Focus at decisions
- Ability to create trust

Organizational climate change

- Organizational control procedures
- Determination of limits for acceptable risks
- Corporation, dialog, involvement of middle managers and workers in decisions
- Rewarding safety system



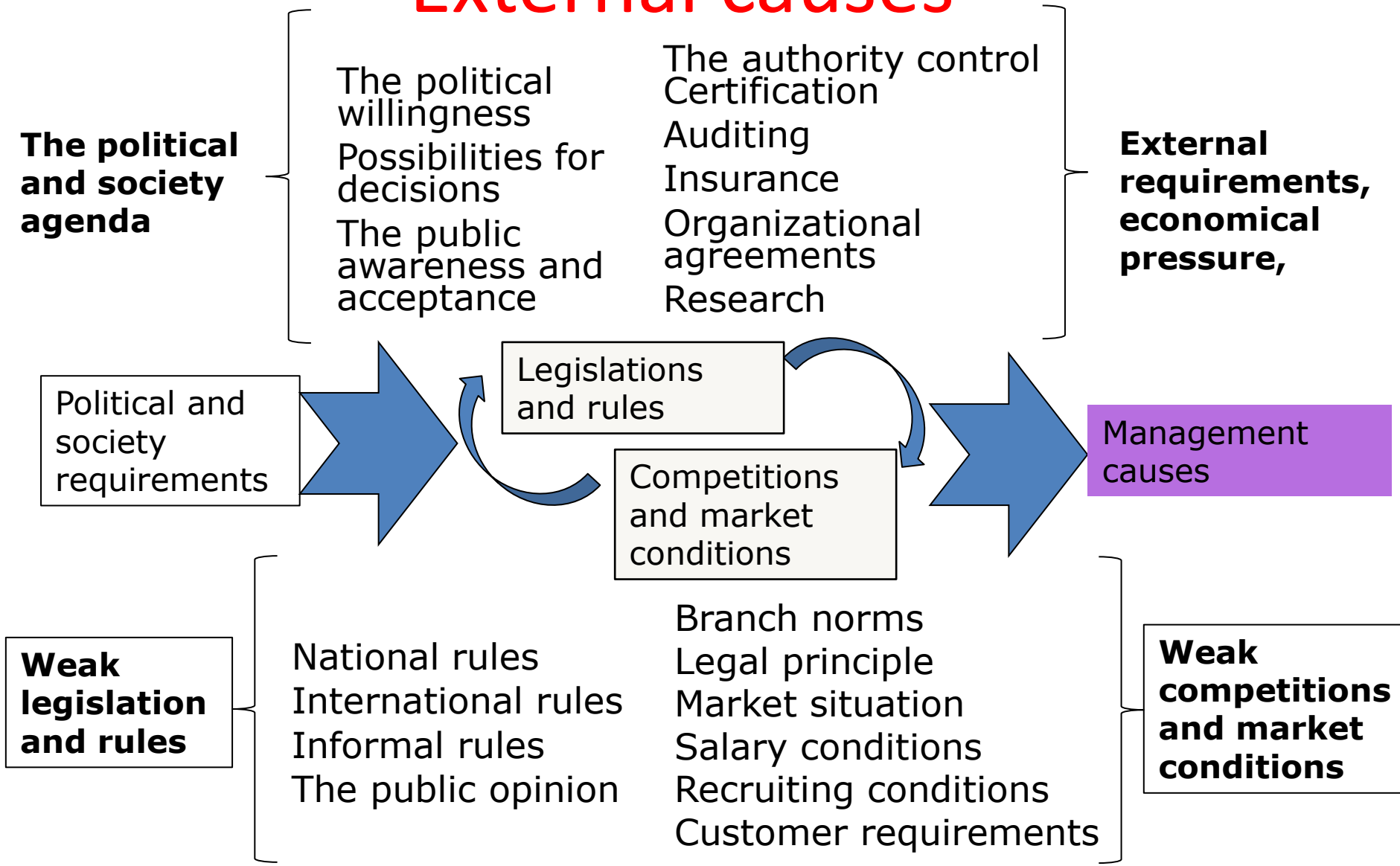
Strategic weakness

- Lack of prioritization of safety
- Lack of Safety management
- Lack of middle managers training
- Lack of Organizational rules
- Lack of goal setting and evaluation

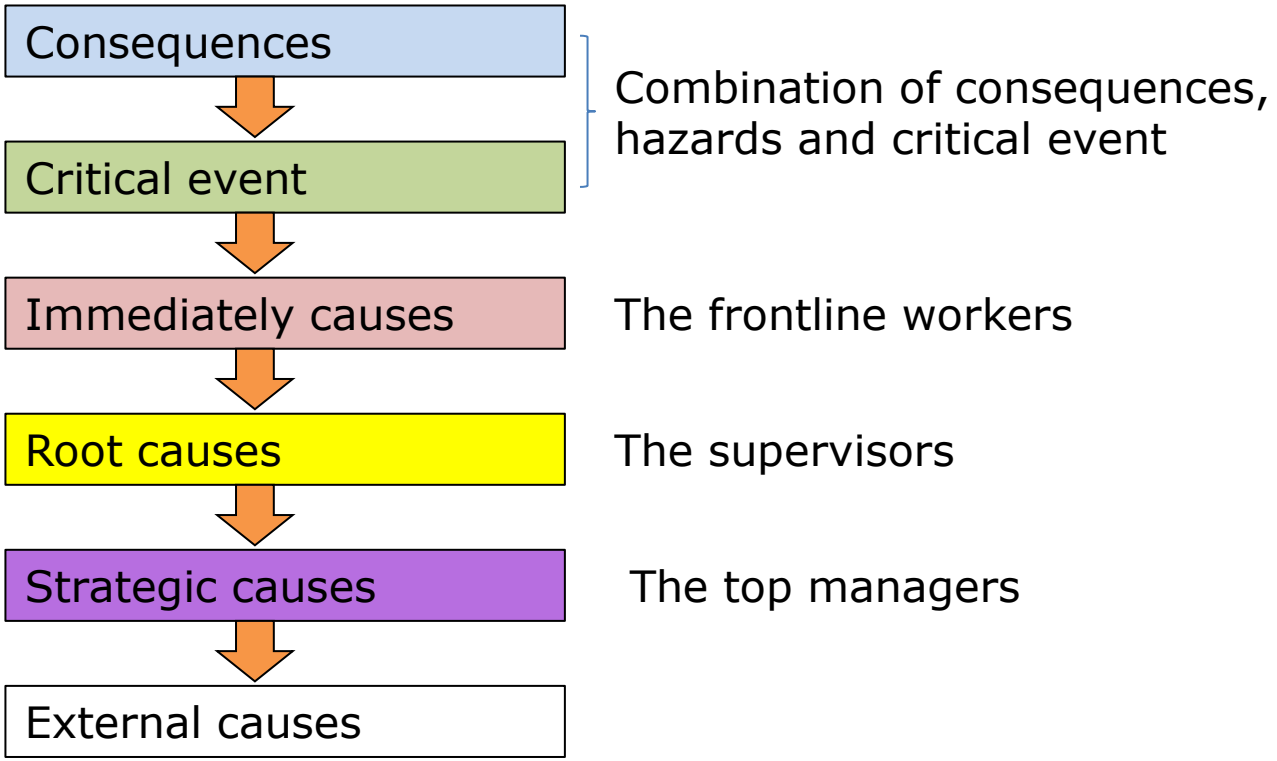
Organizational weakness

- Lack of inspections and audits
- Lack of rewards and consequences
- Lack of requirements towards technical safety
- Lack of planning
- Lack of employee involvement

External causes



What is known from research



What can be questioned

- Do the top manager know what risks problems the workers are facing doing their tasks?
- Do the middle managers and daily supervisors know how to identify risks and do they know how to manage those risks?
- Do the workers know how to identify his own risk situation and do he know how he can manage those risks?

Because hazards are not there always,

Risk occur in situations where combinations of causes are interacting,

It can be too late to act in the dangerous situation

The alternative to control the safety barriers

To be aware of safety barriers

To discover and manage the needs for safety barriers

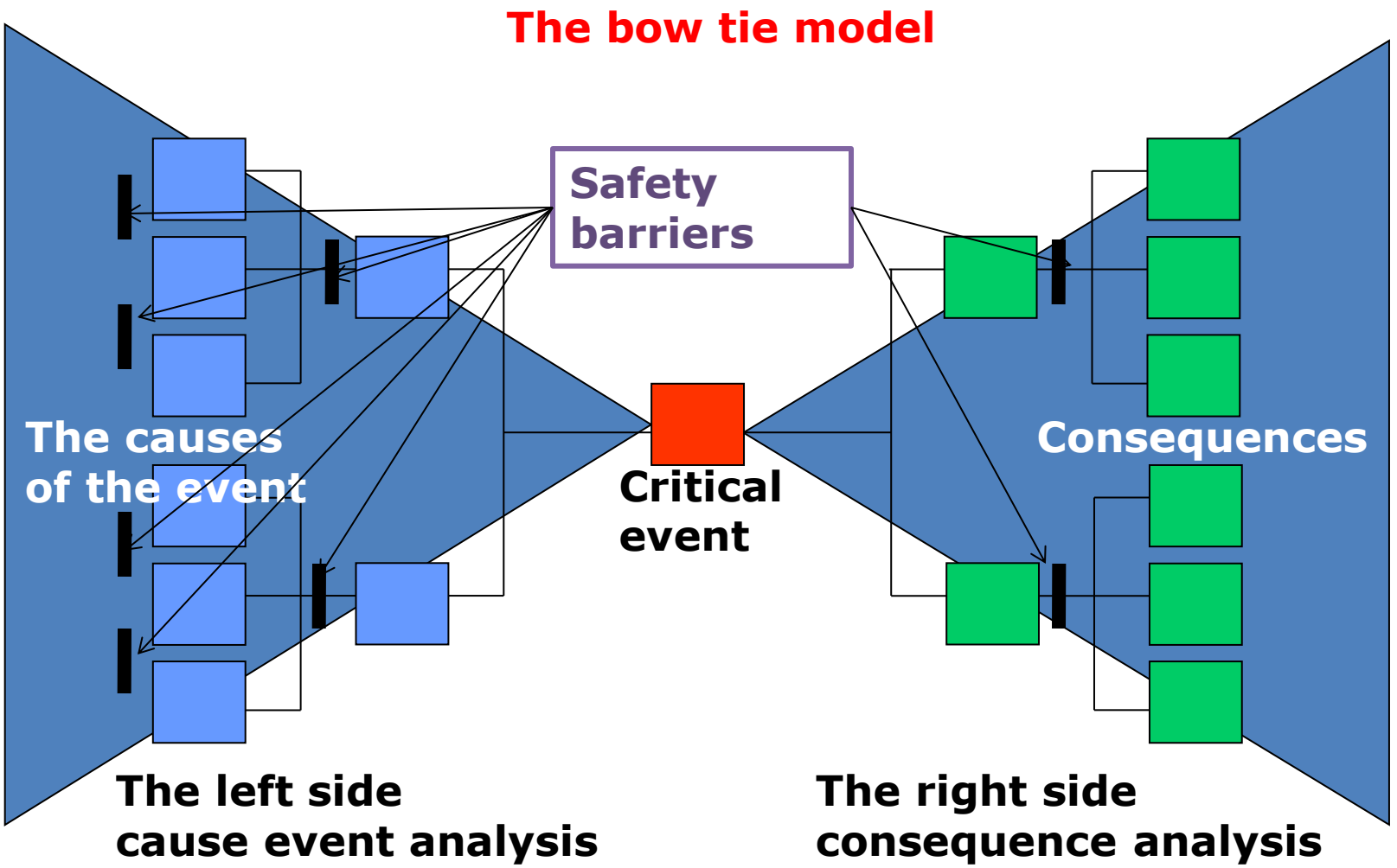
To keep the safety barriers intact

To replace safety barriers with others if needed

To monitor and maintain the quality of safety barriers

Physical and behavioral safety barriers

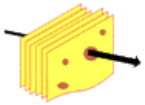
The WORM project



Hazard sources
Safety barriers and PIE´s

Activity hazardous	*Primary safety barriers*	*Support safety barriers*	*Evaluation criteria – PIEs*
Work at placement ladders/ Risk of falling	1 Ladder strength	1. Type of ladder and its strength	Conditions of ladder steps
			Inspection of ladder capacity and length
			Maintenance and storage
			Cleaning
	2. Ladder stability	2. Placement and protection of the ladder	Placement on the ground
			Placement at the top, angle
			Protection against traffic
	3. User stability	3. Ability of the user to stay on the ladder	Position on the ladder
			Personal condition
			Use of both hands to hold onto the ladder
			External forces influence
			Appropriate movements

The WORM system



HUMAN SYSTEM

TECHNICAL SYSTEM

Management Delivery Systems → **Safety Barrier Tasks** → **Safety Barriers** Prevent **Loss of Control Events** → ACCIDENTAL RELEASE OF THE HAZARD AGENT

FAILURE TO DELIVER :

- Procedures
- Equipment
- Ergonomics
- Availability
- Competence
- Communication
- Motivation
- Conflict resolution

FAILURE TO:

- Provide barrier
- Use barrier
- Maintain barrier
- Monitor/ supervise barrier

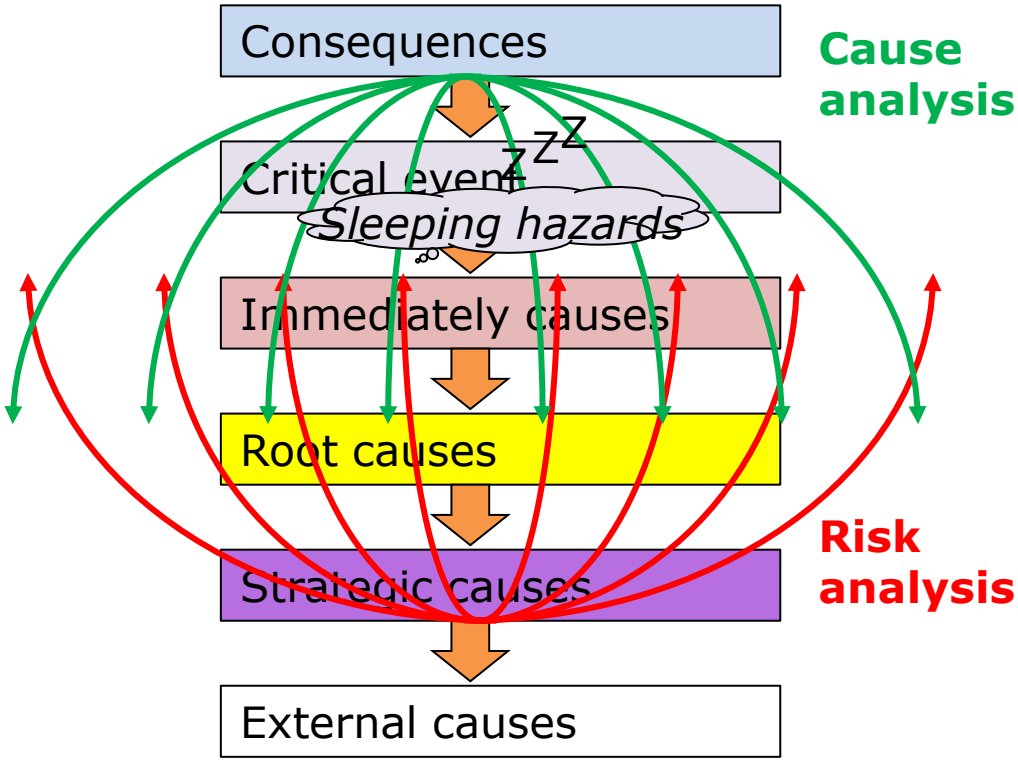
BARRIER FAILURE MODE:

- Undesirable transmission of energy/ hazardous agents/ deviant conditions (e.g. vibration, temperature)
- Failed physical conditions (e.g. structural integrity, strength)
- Hazardous agent/ energy not separated from vulnerable target (e.g. distance of people from hazard)

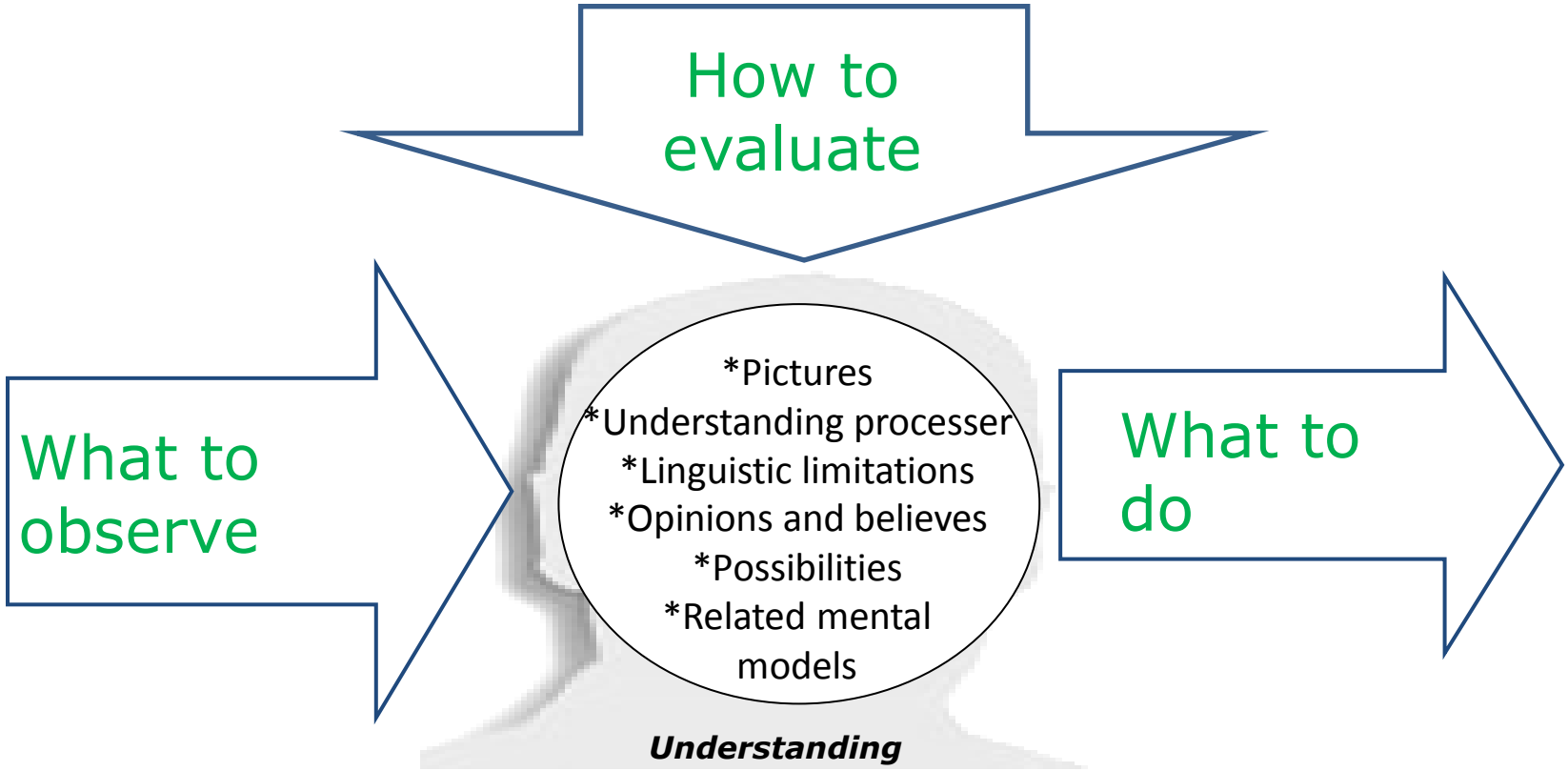
LOSS OF CONTROL:

- Presence, build-up, or release of the hazardous agent/ energy.

The cause analysis versus the risk analysis

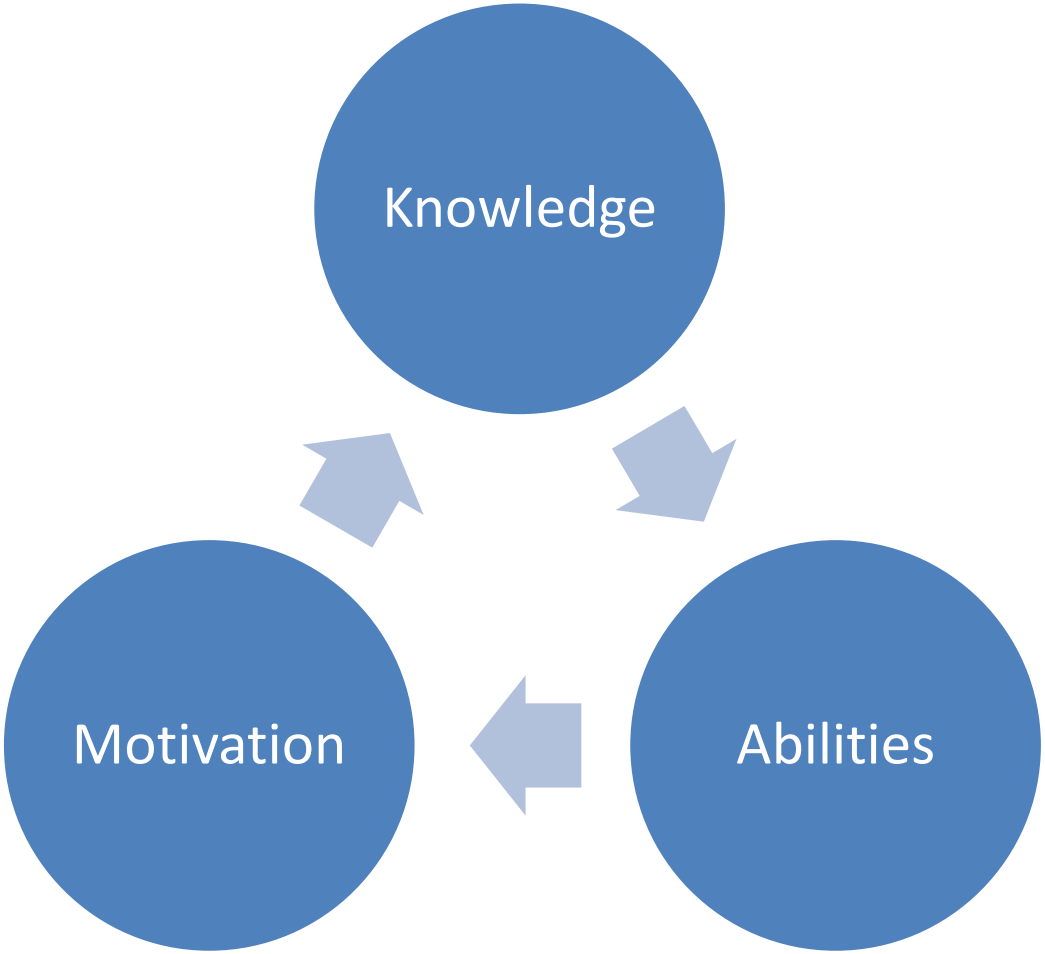


Situational awareness



Kompetences and motivation

Three important elements



Everybody has a responsibility

- **Both employers and employees need to possess safety barrier awareness**
- **The employer have the responsibility in beforehand**
- **The employee have the responsibility in the situation where they very often are on their own**

INFO Cards

For the employer

LEDELSE

Fare: Arbejde i højde med risiko for fald til lavere niveau
Omfatter ophold og arbejde på alle former for tag, skråninger, platforme, niveauforskelle, tage mv.

Barrieretyper	Observer/undersøg	Forstå/tolk og vurder	Handle/udfør
Udstyrets styrke	Observer om udstyret er i orden, rengjort og vedligeholdt. Undersøg hvilket udstyr der er behov for til opgaverne og dets bæreevne. Undersøg om der er behov for andet udstyr til opgaverne. Observer om medarbejderne tilbage-melder når udstyret ikke er i orden. Observer medarbejdernes adfærd og anvendelse af udstyret.	Vurder om konstruktionen er hensigtsmæssig til opgave. Vurder bæreevnen i forhold til opgaven. Vurder vedligeholdelses-tilstanden. Vurder behov for afhjælpende foranstaltninger. Vurder behovet for information til medarbejdere og eventuelt. procedurer for arbejdet Vurder behovet for særlig instruktion. Vurder behovet for motiverende initiativer overfor medarbejderne.	Sørg for mangler udbedres Sørg for det rigtige udstyr kommer i anvendelse Fjern defekt udstyr Informer medarbejderne om hvilket udstyr de skal anvende Informer medarbejderne om hvilket udstyr der er defekt eller er under udbedring Sørg for procedurer for renholdelse og vedligeholdelse Motiver og instruer medarbejderne om hvordan du ønsker de skal forholde sig når de arbejder i højde og hvilke tilbagemeldinger de skal give, når de finder at tingene ikke er i orden
Behov for rækværk	Observer om rækværk er monteret korrekt og i god vedligeholdt tilstand	Vurder tilgængelighed, vedligeholdelse, styrke, opsætning af rækværker. Vurder motivation til at sikre vedligeholdelse af rækværkernes kvalitet. Vurder behovet for særlig instruktion. Vurder behovet for motiverende initiativer overfor medarbejderne.	Sørg for at mangler udbedres Informer medarbejderne om hvordan de skal forholde sig Motiver og instruer medarbejderne om hvordan du ønsker de skal forholde sig når rækværker mangler eller ikke er i orden.
Udstyrets placering og fundering	Observer udstyrets placering of fundering Observer muligheden for ydre omstændigheder kan påvirke udstyret Observer behov for særlige foranstaltninger til sikring Observer medarbejdernes evne til at sikre udstyret Tjek godkendelse af udstyret	Vurder mulighed for udskridning, væltning Vurder mulighed for at nogen kan støde ind I eller påvirke udstyrets balance Vurder medarbejdernes evne og motivation til at opsætte og anvende udstyret korrekt	Sørg for at mangler udbedres Informer medarbejderne om hvad rigtig metode er og sørg for det sker Instruer om opstilling, fastgørelse, fundering, placering mv Motiver medarbejderne til at overholde procedurer
Bruger-stabilitet	Observer medarbejdernes helbredstilstand før de sendes I højden Observer vejrliget før opgaven starter op Observer medarbejdernes adfærd hen under fodtøj, frie hænder	Vurder om medarbejderne er OK Vurder om medarbejderne kan klare opgaven Vurder om medarbejderne ved hvordan adfærden bør være ved arbejde i højde Vurder medarbejdernes motivation til at udvise sikker adfærd	Sørg for klare instruktioner/aftaler Sørg for god fordeling af ansvar og opgaver Skab positiv motivation til sikker adfærd Sørg for en konsekvent holdning overfor misligholdelse

Hazard

Safety barriers

What to observe

Evaluate

To do

For The employee

Medarbejder

Fare: Arbejde i højde
Omfatter ophold og arbejde på alle former for tag, skråninger, platforme, niveauforskelle, tage mv.

Barrieretyper	Observer/ undersøg	Forstå/tolke vurder	Handle/udfør
Udstyrets styrke	Observer om udstyret er i orden, rengjort og vedligeholdt. Undersøg hvilket udstyr der er behov for til opgaverne og dets bæreevne. Undersøg om der er behov for andet udstyr til opgaverne.	Vurder om konstruktionen er hensigtsmæssig til opgave. Vurder bæreevnen i forhold til opgaven. Vurder vedligeholdelses-tilstanden. Vurder behov for afhjælpende foranstaltninger.	Sørg for mangler udbedres Sørg for det rigtige udstyr kommer i anvendelse Fjern defekt udstyr Meddel arbejdsgiver og eventuelle kollegaer hvis forholdene ikke er i orden Følg de givne instruktioner og procedurer
Behov for rækværk	Observer behovet for rækværk Observer nødvendige rækværks kvalitet og styrke Observer om rækværk er monteret korrekt og i god vedligeholdt tilstand	Vurder tilgængelighed, vedligeholdelse, styrke, opsætning af rækværker.	Sørg for at mangler udbedres Meddel arbejdsgiver og eventuelle kollegaer hvis der er mangler og hvilke forholdsregler der er nødvendige Følg de givne instruktioner og procedurer
Udstyrets placering og fundering	Observer udstyrets placering of fundering Observer muligheden for ydre omstændigheder kan påvirke udstyret Observer behov for særlige foranstaltninger til sikring Tjek godkendelse af udstyret	Vurder mulighed for udskridning, væltning Vurder mulighed for at nogen kan støde ind I eller påvirke udstyrets balance	Sørg for at mangler udbedres Meddel arbejdsgiver og eventuelle kollegaer hvis der er mangler og hvilke forholdsregler der er nødvendige Følg de givne instruktioner og procedurer
Bruger-stabilitet	Observer din helbredstilstand før du går i højden Observer vejrliget før opgaven starter op Observer behov for særlig adfærd herunder fodtøj, frie hænder til at holde fast	Vurder din egen evne til at arbejde i højden Vurder om du kan klare opgaven Vurder hvilken adfærd der er behov for i arbejdsopgaven for din og dine kollegaers sikkerhed Vurder metode til transport af materialer og værktøj, som skal anvendes til arbejdet i højden.	Kend til de nødvendige instruktioner/aftaler Kend til hvem der har ansvar og opgaver Sørg for hjælpemidler til at få hejst materialer og udstyr op, så du har en hånd fri til at kunne holde fast Udfør opgaven med en sikker og professionel adfærd

Hazard

Safety barriers

What to observe

Evaluate

To do

INFO cards in three levels

General level hazards	**For all kinds of**	**1**
Cross-cutting level hazards	**For subgroups of**	**17**
Specific level hazards	**For specific**	**64**

Sub groups of Hazards

Subgroup of critical events
Falls from heights
Falls from the same level
Being struck by falling objects
Being struck by fragments
Being struck by moving objects, becoming caught up/jammed, crushed.
Becoming buried
Violence
Being struck by moving objects, becoming caught up/jammed, cutting
Collisions
Electric shock
Burns
Poisoning, etching
Strain injuries
Electric shock
Fire
Suffocation, poisoning or drowning
Explosion

The general INFO cards

for all kind of hazards

Managers' generic INFO card		
Observe	**Evaluate**	**Act**
Observe whether…	***Evaluate the need for…..***	***Act to ensure provision, use, maintenance and monitoring /improvement of safety barriers for….***
Safeguarding is provided and used by the employee	Better safeguarding	Safeguarding
Personal protective equipment is provided and used by the employee	Better personal protective equipment	Personal protective equipment
Operational control of the technical system is safely provided and managed safely by the employee	Better operational control system	The operational control system
Avoidance of the danger zone is provided for in the task and respected by the employee	Better avoidance of danger zone	Avoidance of danger zone
Emergency response is provided and able to be used by the employee	Better emergency response	Emergency response
The employee's health condition is satisfactory and enables them to do the task safely.	Better health monitoring and if it is necessary, changing the employee's current task	Employees who are in poor health condition (change the task)
The employee has the right knowledge and skills and is using them correctly	More training and instruction	Competence (through training and instructions)
Information about risks and safety barriers is communicated to and understood by the employee	Better communication of information about risks and safety barriers	Communication about the risks and safety barriers
Safe equipment is provided and used by the employee	Improving equipment to be in a safe condition, right for the task and possible to use in a safe way	Equipment changed to a better and more safe product
Safety is integrated into plans and procedures for the task and followed by the employee	Improving plans and procedures so they are right for the task and possible to follow by the employee in a safe way	Plans and procedures adapted to be safe for the task and to the level of understanding of the employee
Equipment, technical devices, and the workplace conditions are provided in an ergonomic and safe design and used by the employee and maintained	Improving equipment, technical devices, workplace conditions so that they are in a proper ergonomic condition	The ergonomic design of equipment, technical devices, work surroundings
Sufficient and qualified people are available for the routine and non-routine tasks when needed	More people or people with other qualifications for the tasks (including in the night, for emergency response and specialist tasks that are rarely carried out)	The availability of qualified people for all the possible task demands
There is pressure to carry out the task in a quicker and less safe way due to conflict with operational goals or other tasks	Removing the conflict situation between tasks and goals so that the employee will choose to do his task the safe way and ensuring the employee is getting the right message from management about the importance of safety.	Reduction or removal of the conflict between safety and production, ensuring that safety is prioritised over production goals when they come into conflict
The employee is motivated to carry out the task in a safe way	Improving the employee's motivation and awareness for carrying out the task in an acceptably safe way, including improving the effectiveness of motivational and awareness raising initiatives and maintaining alertness on a continuing basis	Motivation and risk awareness of the employee for carrying out the tasks in a safe way on a continuous basis, including the removal of distractions, maintenance of alertness

Safeguarding is provided and used by the employee

Personal protective equipment is provided and used by the employee

Operational control of the technical system is safely provided and managed safely by the employee

Avoidance of the danger zone is provided for in the task and respected by the employee

The employee's health condition is satisfactory and enables them to do the task safely.

The employee has the right knowledge and skills and is using them correctly

Information about risks and safety barriers is communicated to and understood by the employee

Safety is integrated into plans and procedures for the task and followed by the employee

Equipment, technical devices, and the workplace conditions are provided in an ergonomic and safe design and used by the employee and maintained

Sufficient and qualified people are available for the routine and non-routine tasks when needed

The employee is motivated to carry out the task in a safe way

Cross-cutting INFO cards

for 17 sub-groups of hazards

Managers cross cutting INFO card for falls from height

Observe	Evaluate	Act
Observe whether…	*Evaluate the need for…..*	*Act to ensure provision, use, maintenance and monitoring /improvement of safety barriers for….*
Strength of supporting equipment or structures when working at height is in good order and clean	Checking and providing strength and cleanliness of the equipment or structures when working at height.	Making sure that structures that have to be worked on are strong enough to support persons and other loads. Maintaining or replacement of the equipment. Maintaining strength of structures for working at height.
There is a need for edge protection and if so that the edge protection is of good quality and correctly installed	Checking edge protection quality and correct installation/fixing in place	Maintaining or installing edge protection of appropriate safe design
The placing of equipment (including what it is placed on) and the possibility for it to be affected by external circumstances could affect its safe use.	Adjustment of how equipment is placed and the possibility for external circumstances which could affect its safe use	The secure placement of equipment Maintaining safeguarding against external circumstances that could affect the integrity of the equipment
Competences for using the equipment or being at height is provided and used by the employee.	Instruction/training for working at height	Maintaining workers´ competences for working at height
Employee is motivated to use the equipment or work at height in a safe way	Motivation actions towards working at height	Maintaining the motivational activities for safe behaviour when working at height

Strength of supporting equipment or structures when working at height is in good order and clean

There is a need for edge protection and if so that the edge protection is of good quality and correctly installed

The placing of equipment (including what it is placed on) and the possibility for it to be affected by external circumstances could affect its safe use.

Competences for using the equipment or being at height is provided and used by the employee.

Employee is motivated to use the equipment or work at height in a safe way

Specific INFO cards

for 64 specific hazards

Managers specific INFO card for falling from non-moving vehicle		
Observe	**Evaluate**	**Act**
Observe whether….	**Evaluate the need for….**	**Act to ensure provision, use, maintenance and monitoring/improvement of safety barrier for…**
Equipment strength		
The vehicle is strong enough to support the weight	Limitation of weight	Vehicle is strong enough for the weight
The vehicle is overloaded or loaded one-sidedly	Changes to the loading method	The correct load and balanced loading methods
Edge and access protection		
Edge protection is absent, insufficient or has been removed or is broken	Edge protection	Adequate edge protection
The vehicle and the load are safely accessible for the required activities	Changing the access	Safe access to vehicle loads
Equipment placement		
The vehicle placement is stable	Changing the placement of the vehicle	Stable placement of vehicle
Load configuration is stable	Changing the load configuration	Stable load configuration
Load displacement/movement/loading or unloading threatens user stability or the stability of the vehicle	Changing the displacement/movement/ loading or unloading procedure	Displacement/movement/loading or unloading procedures to prevent instability
Employer ability and competences		
The employee is able to keep balance	Prevention of loss of balance	Being fit enough to balance on the vehicle
The employee is able to work safely on the non-moving vehicle	Changing the work conditions that might cause loss of balance	Work conditions for preventing loss of balance
The access behaviour is safe	Changing access behaviour	Safe access behaviour
The surface conditions are safe for the activity, also with respect to access	Changing the surface conditions that might cause loss of balance	Safe surface conditions for the activities, also with respect to access

Managers specific INFO card for falling from non-moving vehicle		
Observe	**Evaluate**	**Act**
Observe whether….	**Evaluate the need for….**	**Act to ensure provision, use, maintenance and improvement of**

Employer ability and competences		
The employee is able to keep balance	Prevention of loss of balance	Being fit enough to balance on the vehicle
The employee is able to work safely on the non-moving vehicle	Changing the work conditions that might cause loss of balance	Work conditions for preventing loss of balance
The access behaviour is safe	Changing access behaviour	Safe access behaviour
The surface conditions are safe for the activity, also with respect to access	Changing the surface conditions that might cause loss of balance	Safe surface conditions for the activities, also with respect to access

What has been demonstrated

Different hazards needs different safety barriers and different management delivery processes

Some safety barrier is generic but other are very specific

Accident are not all of a kind because they relate to different hazards, different needs for safety barriers and different management deliveries.

The challenges for creating of safety

1. problem

- The top manager, the daily supervisor and the employee has many duties
- As long nothing has happen the everybody presume everything is OK
- Jens Rasmussen´s drift to danger is very difficult to observe in the daily routine

The challenges for creating of safety

2. problem

- The safety system and knowledge found for prevention initiative has been found in larger companies.
- Most enterprises is SME´s and most accidents happens in SME´s

The challenges for creating of safety

3. problem

- Very few actually understand how hard it is to create safety and keep the safety level on the top

How to create safety

1. proposal

- To see safety as an integrated part of creating a more efficient working process and making good economical results.
- To ensure that effectiveness includes safety and quality by making the easy way to perform a job to be the safest.

How to create safety

2. proposal

- To change the view of the meaning of being a professional for top managers, daily supervisors and all kind of employments.
- To be a professional in the job must include to make the job in a safe and quality right way.

How to create safety

3. Proposal

- To distinguish prevention methods for different hazards, prioritize and make prevention step by step.
- Accept there is no easy route, it is hard work.

The human factor

- **People can work day in and day out in a hazardous environment.**
- **Through their thoughtfulness, ingenuity, attention and physical abilities they can compensate for poorly designed equipment, facilities and routines, and thus prevent the risks being triggered.**
- **Then one day in a few seconds someone loses his or hers attention and the accident happens.**
- **For that moment the human factor is recognized**

We have not many accidents because of the human factor – it is because of the human factor we have so few.

Carin Sundström-Frisk 1982

Safety engineering

- **Integration safety in technologies**
- **Integration safety in projects and processes**
- **Make safety the easy way and the easy way to be the safe**

- **Prepare instructions, maintenance procedures, clear and visible icons for what to remember**
- **The remaining risks or hazards, must be clear where and when and how to manage**

The simple accidents are simple to analyze and understand when the accident has happened

But to observe the hazards and be aware of and take the risk serious are most difficult

To be a professional at all power level must include to carry out the job safely- that means to make sure all necessary safety barrier are in place

Thank you for listening